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OSMOTIC ADJUSTMENT OF ROOTS

U. Schmidhalter, M. Evéquoz, and J.J. Oertli
Department of Agronomy, Institute of Plant Sciences,
ETH Zürich, Switzerland

Plants have evolved numerous mechanisms to cope with water stress. Often, a water stress leads to a greater root/shoot ratio. This root growth may not only be increased relatively, but absolutely as well. There are limited data to suggest that roots make some osmotic adjustment under water stress. The advantage of such an adjustment of roots in a dry soil would be found in the maintenance of root turgor, and thus the maintenance of root growth. More soil volume can then be explored for available water. Osmotic adjustment further allows plants to adapt to saline conditions.

Osmotic adjustment in roots has been investigated only little. It is regarded as an important adaptive mechanism to drought stress and salinity. Therefore, this study was conducted to investigate the osmotic adjustment in roots of young seedlings of several plant species.

Plants may react to decreasing external water potentials by decreasing internally their osmotic potential. Osmotica used for adjustment to decreasing water potentials may originate from external uptake of solutes or from internal production or translocation of existing solutes.

Osmotic adjustment in a saline medium is generally favoured by the presence of solutes, whereas in the case of matric stress the plant is much more dependent on internally generated osmotica. The metabolic energy used in osmoregulation is probably higher in water-stressed plants where solutes have to be derived, to a greater extent, from internal production. Reflection coefficients lower than unity as observed for the uptake of several solutes in roots might cause external osmotic potential components to be less effective in restricting water uptake than matric potential components.

The results obtained with several species suggest that roots can adjust osmotically. Comparative investigations done to determine the effects of salt and water stress on barley and corn plants showed that shoots osmoregulated more efficiently under salt stress than water stress, whereas roots did not differ to any great extent. This suggests that roots may be better adapted to water stress than shoots, which is further supported by the enhanced root growth. Root growth was generally favoured over shoot growth under water stress. Stress enhanced root growth, not only relative to shoot growth, but absolutely as compared to roots of well watered plants.

The better growth of roots as compared to shoots is probably due to their greater capability to adjust osmotically. Under mild water stress, CO_2 assimilation was not affected. This was reflected by an increase in plant dry weight due to the greatly increased root growth. The greater amount of assimilates made available by the reduced sink strength in the shoot permitted osmotic adjustment of roots and thereby increased root growth. Roots can represent very strong sinks under moderate drought stress which can substantially determine the corresponding plant assimilate distribution. Under such conditions, photosynthetic capacity may be increased for limited periods. It seems that sink capacity is positively correlated with a high solute concentration.

It is suggested that increases in root/shoot ratio under water stress are due to a more efficient osmotic adjustment of roots. Relative or absolute increases in root growth as compared to control plants, which are well watered, probably indicate that roots adjust osmotically to decreases in the water potential. Several species, e.g. barley, rye, wheat, sunflower, carrots showed under the investigated conditions an absolute increase in plant dry weight. This was based on a strong promotion of root growth under moderate stress conditions. Increased root growth was especially pronounced in barley plants. These plants might be especially well adapted to drought conditions. No such increases in absolute root growth were observed in another group of plants, to which corn and soybean belonged. These plants demonstrated only a relative increase in root growth. However, in both groups, plants were found, which showed osmotic adjustment of roots. Osmotic adjustment of roots is probably influenced by several factors: Optimal nutrient supply favours adaptation. Under this condition osmotic adjustment in roots may occur under rapid and low stress. Low light intensity also seems to positively influence root growth and probably also osmotic adjustment under water stress. Osmotic adjustment in roots may thus be very much dependent on the rate of soil drying as well as on the external atmospheric conditions.